Appendix A-4

A. RTV as an Approach that will Increase Capacity

NET NEW JOBS BY SUB-STATE REGION 2010-2030		
Jurisdiction	Net New Jobs	Percent Change
District of Columbia	152,130	20.8%
Suburban Maryland	316,525	32.9%
Montgomery County	*163,008*	*34.5%*
Northern Virginia	578,480	54.9%
WASHINGTON REGION	1,053,855	38.2%

Source: IHS Global Insight, GMU Center for Regional Analysis (2012)

1. The Diminishing Capacity of Auto Lanes/The Increasing Capacity of RTV Lanes

There are absolute theoretical physical limits on the people-moving capacity of each of our State and County auto lanes in Montgomery County; whereas the upper limits of the people-moving capacity of one dedicated RTV lane could be as much as 5 or 6 times, or more, than the auto lane people-moving capacity, if the RTV lanes had full vehicles running on 3 minute headways[1]. Accordingly, if over the course of the next 20 years or 40 years or beyond, State and County roads needed to have the capacity to move, for example, **triple** the number of people who now move on those roads (as is the implication of the Center for Regional Analysis's projections noted in Section _____ above), we would effectively need to acquire additional right-of-way to triple the number

[1] The term "headway" is defined as the length of time between vehicles on a given route.

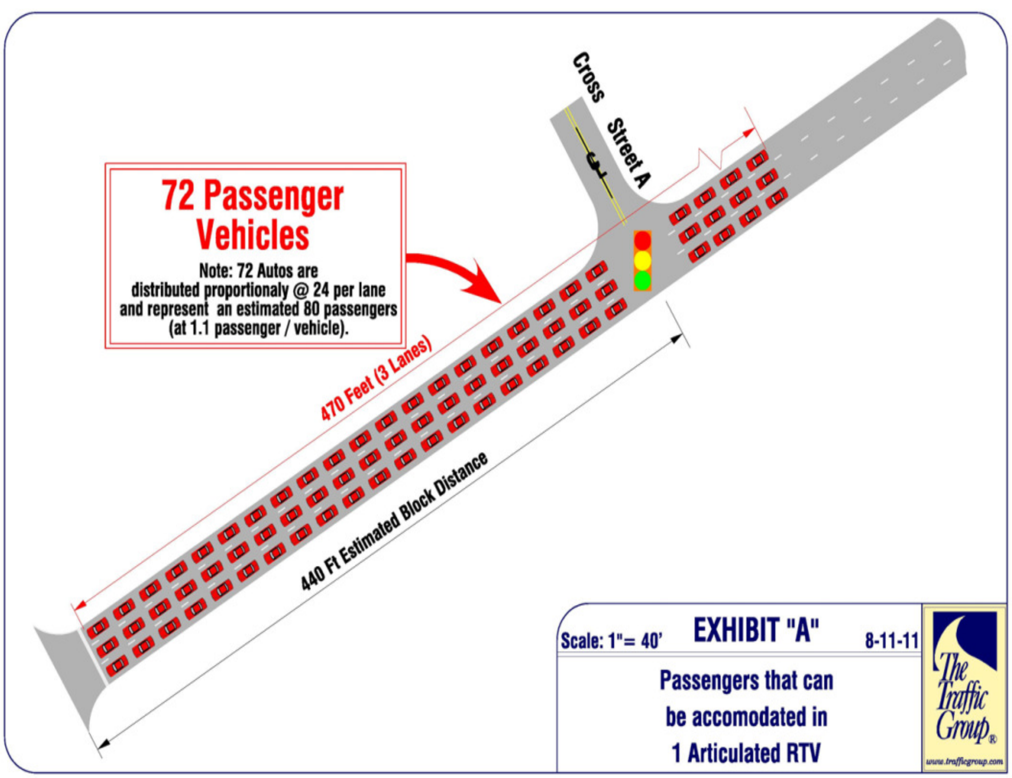
of auto lanes to meet that demand (e.g., a 4-lane road today would need to be expanded to 12 lanes), just in order to maintain the same level of service in moving people through intersections. Conversely, one dedicated RTV lane could have the expanding capacity to remove 3 lanes of traffic, or more.

Some examples of RTV designs that are included in the Transit Task Force's recommendations, together with their potential people-moving capacity per vehicle, and the estimated number of cars that could be removed from our roads by use of these unique, sleek, and stylish RTVs, are the following:

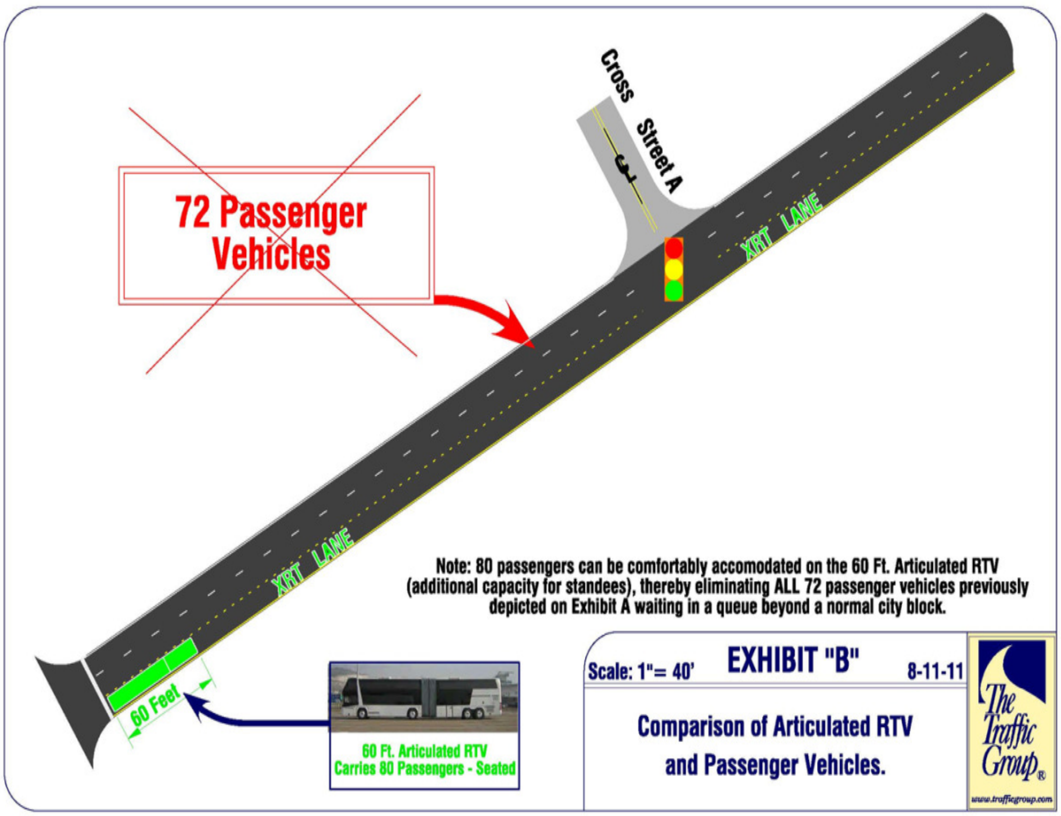
Example #1: An articulated RTV; capacity up to ~140 passengers; potential to remove up to ~120 cars off the roads.

Example #2: A double-articulated RTV; capacity up to ~180 passengers; potential to remove up to ~150 cars off the roads.

As an example of the auto-removing potential --- and the resulting de-congesting of our roads --- of one articulated RTV (presuming ~60% occupancy of that RTV, or ~80 passengers), the first chart below ("Exhibit A") depicts 72 passenger cars backed-up in 3 auto lanes, grid-locked from one typical urban block length to beyond the previous intersection, representing approximately 80 people traveling in those lanes.



The second chart below ("Exhibit B") depicts the number of cars that could be removed from the auto lanes, presuming those same ~80 people were seated in one RTV (at ~60% occupancy).



Essentially, all of the autos disappear from the road.

This demonstration, through the use of these two charts, in no way is intended to suggest that 100% of the auto drivers would shift to traveling by RTV. Instead, these charts are intended merely to demonstrate the extraordinary people-moving potential of the proposed RTV network, and the RTV system's most efficient use of the square footage of potentially available right-of-way between building faces aligning our streets.

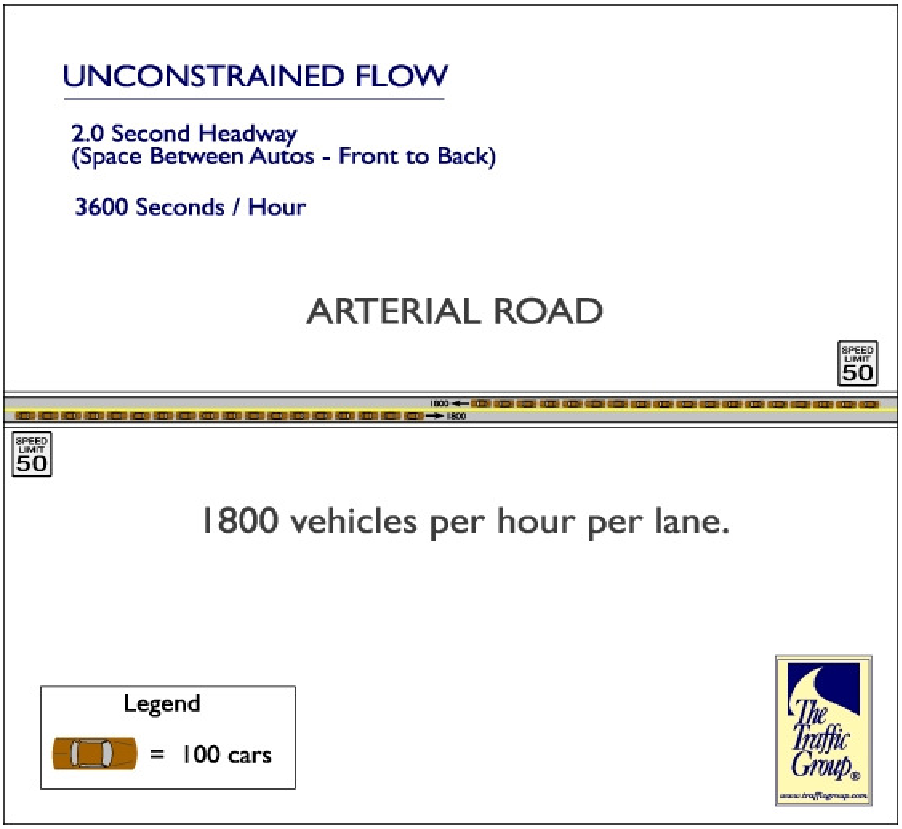
These depictions highlight the potential ability of the proposed RTV system to significantly reduce the need to acquire substantial additional right-of-way to meet the anticipated people-moving demands in the future. For example, a corridor designed and constructed with two-way dedicated RTV lanes could have the future people-moving capacity of 8 or more auto lanes. The RTV system, therefore, has the potential to eliminate the need to acquire enormous acres of private land, private homes, and private commercial businesses, and yet still meet the people-moving demands of the next 20 years, 40 years, 60 years, and beyond.

<u>Calculating the Comparative Consumption of Real Estate Per Lane Per Hour.</u>

One method of computing the congestion-creating effect of automobile use today is through an analysis of the amount of linear real estate is consumed per lane per hour (presuming peak hour traffic conditions). That analysis is substantially as follows:

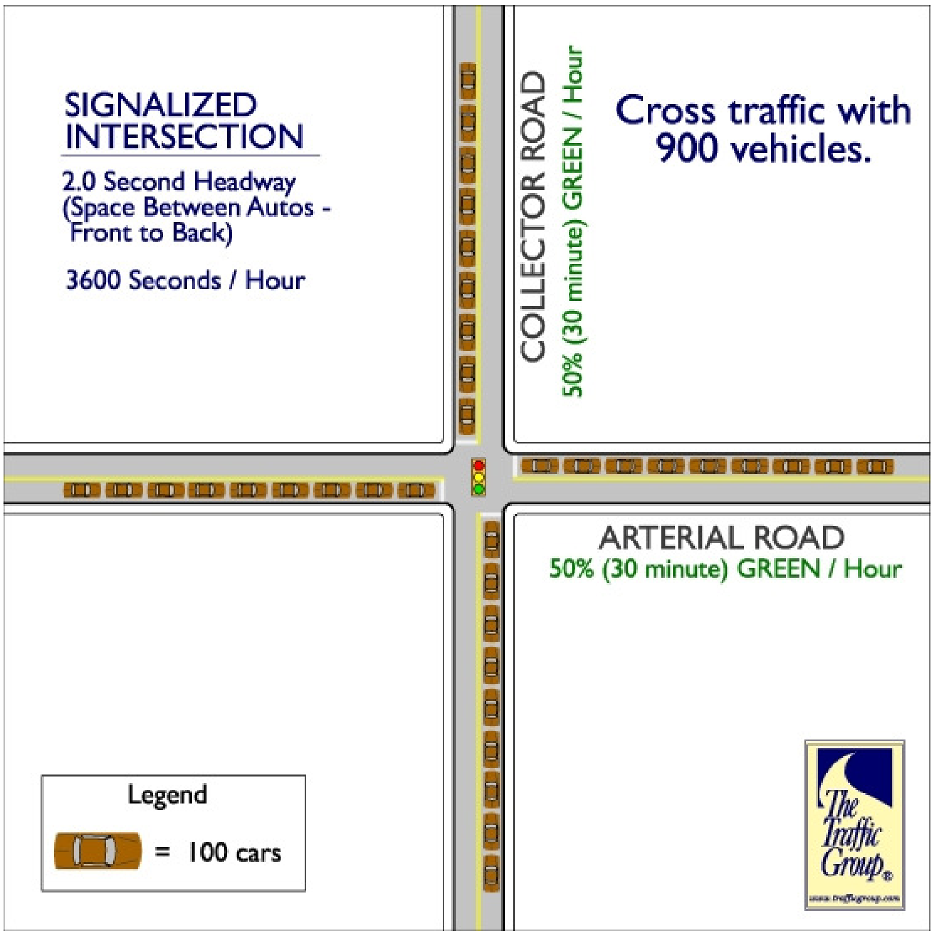
a) Ordinarily the number of people per automobile traveling during peak rush hours range **<u>between 1.10 and 1.15 people per vehicle</u>**.

b) Ordinarily, one auto lane can have up to ~1,800 vehicles per hour travel through an intersection at maximum optimal conditions (meaning no cross traffic needing to use signalization, and no congestion backing up to the applicable intersection, so that the maximum number of cars could proceed directly through the intersection). This ~1,800 figure is based upon the most ideal timing of an average of one car passing through an intersection every 2 seconds (e.g., 3,600 seconds in one hour divided by 2 seconds per car = 1,800 cars).

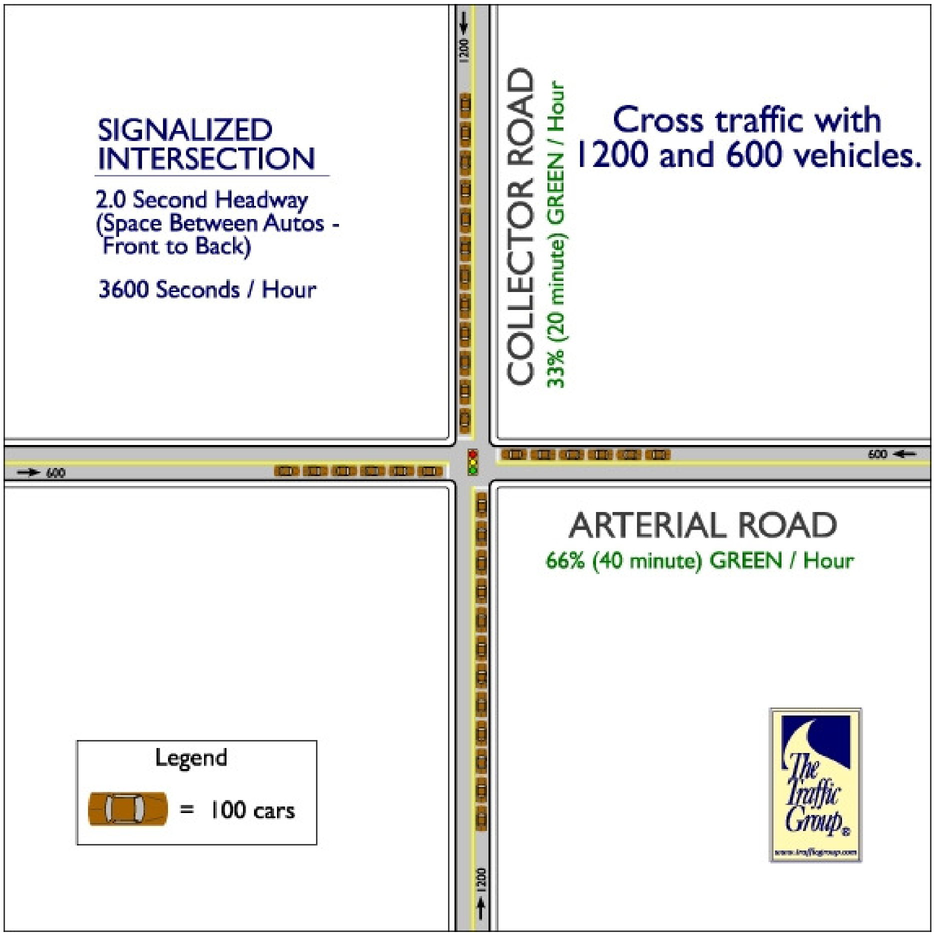


c) Where, however, cross traffic also demands signalization time for vehicles to cross through the intersection, that ~1,800 vehicles per hour per lane become distributed among those cross-traffic patterns. Examples of such distribution of cross-traffic capacity are as follows:

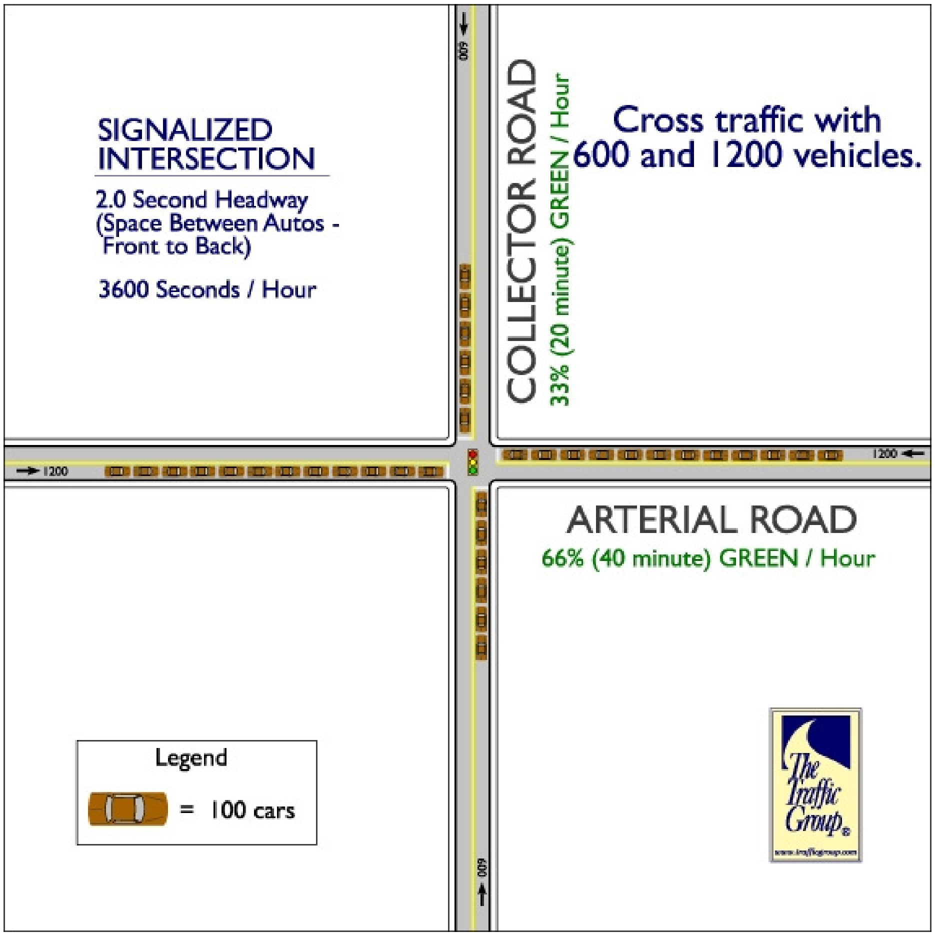
i) If the North-South directional lane and the East-West directional cross traffic lane had equal demands for passage through the same intersection, then each directional flow would have a capacity of moving ~900 vehicles per hour per lane.



ii) If the North-South directional lane had twice the demand of the East-West directional cross traffic lane through the same intersection, then the North-South directional flow would have a capacity of moving ~1,200 vehicles per hour per lane, and the East-West directional flow would have a capacity of moving ~600 vehicles per hour per lane.



iii) If the North-South directional lane had half the demand of the East-West directional cross traffic lane through the same intersection, then the North-South directional flow would have a capacity of moving ~600 vehicles per hour per lane, and the East-West directional flow would have a capacity of moving ~1,200 vehicles per hour per lane.

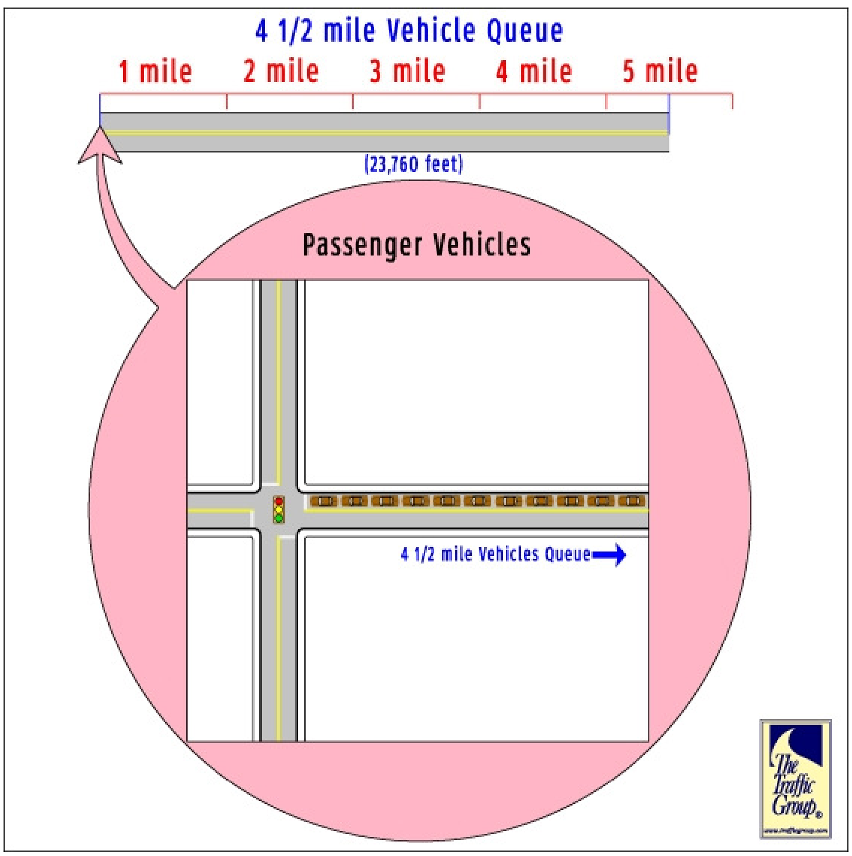


iv) The most congested lanes in our County are those with the higher demands for directional flow than most of their cross directional traffic. But even the higher demanding lanes eventually match up to a high demanding cross directional lane at some point, a fair average to presume for analysis purposes is our high demanding directional lanes would **average ~1,200 vehicles per lane per hour**.

v) As a result of these presumptions, a fair average of people-moving capacity of a high demanding directional flow auto lane is in the range of

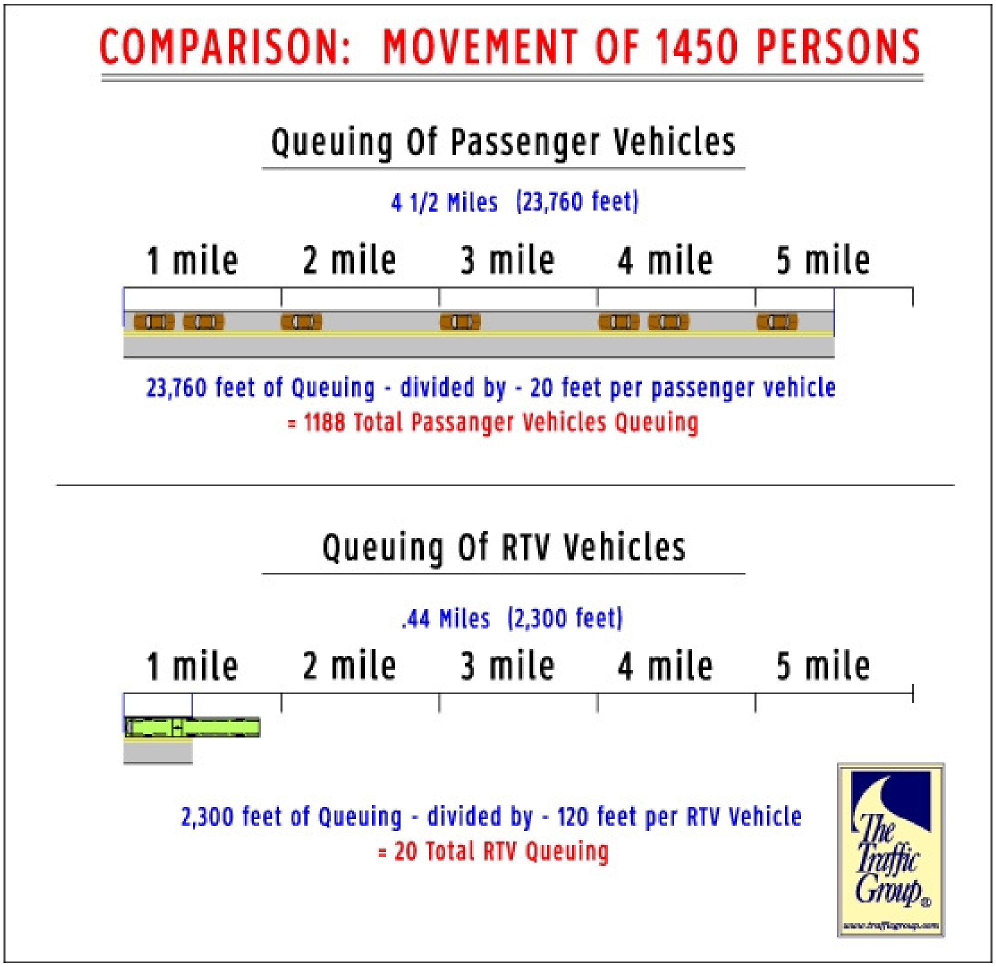
~1,320 to ~1,450 people per lane per hour (i.e., the low range of 1.1 people per vehicle times 1,200 vehicles per lane per hour; and the high range of 1.15 people per vehicle times 1,200 vehicles per lane per hour).

vi) On average, with a reasonable safe distance between cars traveling in one lane, each car consumes approximately 20 linear feet of lane space. As a result, moving up to ~1,450 people per hour (in ~1,200 vehicles) in one auto lane translates to consuming up to **~24,000 linear feet of real estate** (or ~4.5 miles of auto lane back-up).



vii) In contrast, even presuming only ~60% occupancy on one articulated RTV (or ~80 people), more than ~1,450 people per hour could be transported in 19 RTVs. With a reasonable safe distance between RTVs traveling in one lane, each RTV consumes ~120 linear feet of lane space. As a result, moving more than 1,450 people per hour in one RTV lane would translate to consuming less **than 2,300 linear feet of real estate** (or less than ~0.5 miles of RTV back-up).

viii) This comparison demonstrates that RTVs can move at least the same number of people (or more) in ***LESS THAN ONE-TENTH THE AMOUNT OF LINEAR FEET*** per lane per hour than a comparable auto lane.



This spatial comparison is not intended to suggest that RTVs and autos travel comparably in terms of both time and space. Rather, this analysis is intended to demonstrate why auto lanes are far more likely to cause a grid-lock back-up. In order to move ~1,450 people in an auto lane per hour, nearly 4.5 miles of cars need to be absorbed "down-stream" from a particular intersection in order to keep that lane free-flowing. Stated another way, at the end of one auto lane corridor, ~4.5 miles of cars need to be parked in garages or lots at their respective destinations and off the road in order to prevent backing up of traffic. To the extent that ~4.5 mile line of cars is delayed in getting parked and off the road, those cars contribute to the back-up, which, in turn, clogs up the ability for cars "up-stream" from having free flow through those intersections.

1. The Cost-Effective and Efficient Strategy: The Proposed RTV Network

Understanding the spatial analysis above --- that is, the ten-fold consumption of linear feet by autos to move the same number of people in RTVs --- should aid in understanding yet another phenomenon. Given the average throughput of ~1,200 vehicles per lane per hour (or ~1,350 to ~1,450 people per lane per hour in auto), that represents essentially the MAXIMUM number of people that could be transported through a particular intersection, because that number presumes MAXIMUM OPTIMAL FLOW CONDITIONS (of one car passing through an intersection, regardless of direction, for every 2 seconds).

But, there are times when those maximum optimal flow conditions simply do not exist, and for a variety of reasons. Weather conditions may be one cause for delays (e.g., rain or snow). Accidents or disabled vehicles clogging one of the lanes may be another cause for delays. Ride-On buses or MetroBuses picking up or discharging passengers at a bus stop may be another cause for delays. And another major culprit is the back-up of cars past the intersection, so there is no place for cars to go through the intersection.

All of these conditions contribute in varying ways to a reduction in the number of vehicles that actually pass through a given intersection when the optimal flow conditions do not exist. In optimal flow conditions, approximately 100 cars can pass through an intersection in a 5-minute light cycle. How many times have you witnessed an intersection that could meet the optimal flow of ~100 vehicles per 5-minute light cycle at off-peak hours (say, at 11pm); but at the peak rush hours only 5 or 10 cars (or even less) get through the grid-lock?

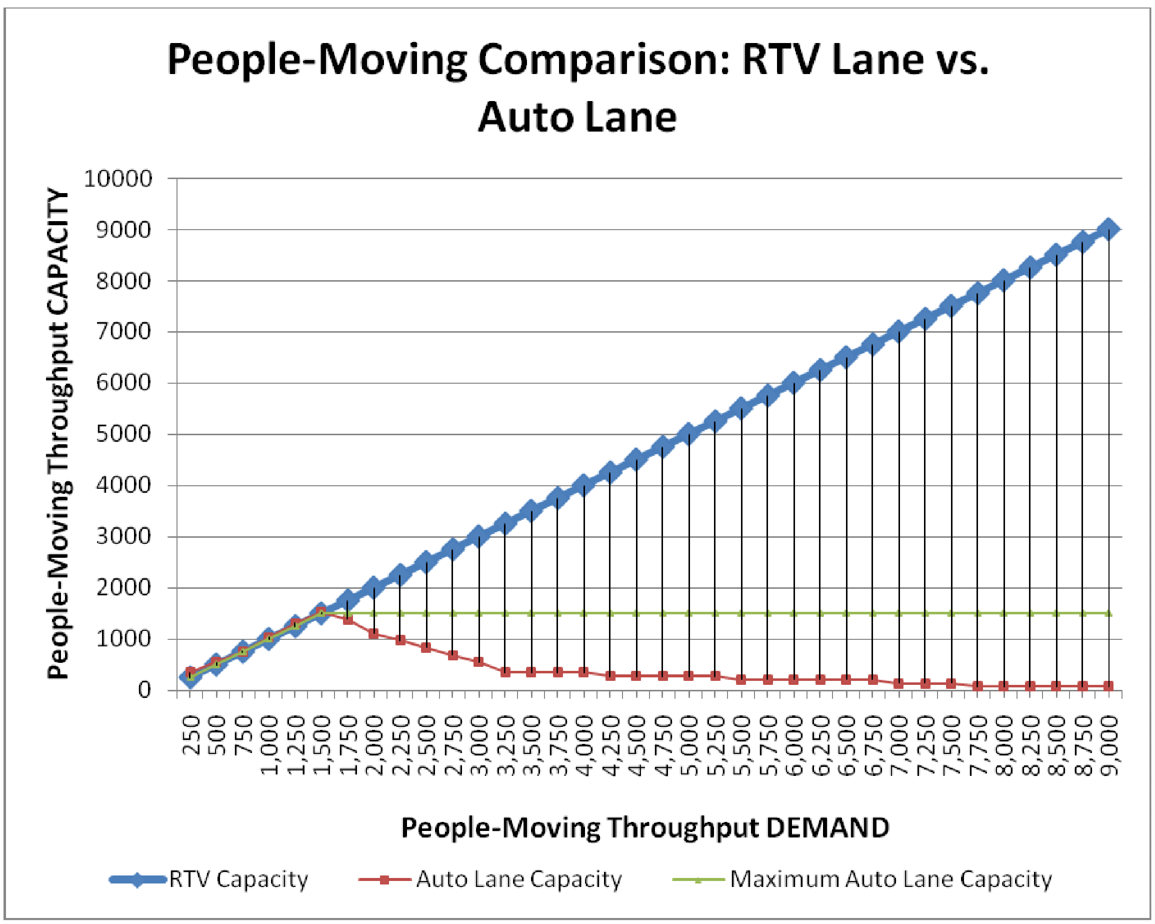
This phenomenon demonstrates one of the disadvantages of relying on autos to move people through congested intersections. Specifically, once the auto lane has reached its people moving capacity of ~1,350 to ~1,450 people per lane per hour (in ~1,200 vehicles per lane per hour), then the more people needed to be moved through that intersection, the fewer people actually can proceed through the intersection. Stated another way, auto lanes have DIMINISHING capacity to move people once the lane reaches its capacity, (either the optimal number of ~1,200 vehicles per lane per hour, or some number less than that due to weather, accidents, back-ups, or some other unusual event).

In stark contrast, RTV lanes have the potential for extraordinarily high people-moving capacity per lane per hour. As previously noted, the articulated RTV shown above has a capacity of up to ~140 passengers. At 5 minute headways (or 12 RTVs per hour), those RTVs could transport ~1,680 passengers. BUT, if future demand required it during peak-peak rush hours, those articulated RTVs could be even be scheduled for 2 minute headways (or 30 RTVs per hour) and thus those **articulated RTVs could transport ~4,200 people (or nearly 3 times what one auto lane could carry)**.

Moreover, the double-articulated RTV shown above has a capacity of up to ~180 passengers. At 5 minute headways (or 12 RTVs per hour), those double-articulated RTVs could transport ~2,160 passengers per hour. And at 2 minute headways (or 30 RTVs per hour) those **double-articulated RTVs could transport ~5,400 people (or**

nearly 4 times what one auto lane could carry). **In fact, the more demand for people-moving capacity, the more valuable the RTV system could be.**

The chart below describes in graphic terms the dramatic comparison of the people-moving capacity of a dedicated lane of RTVs versus the maximum optimal people-moving capacity of an auto lane. Indeed, when grid-lock occurs for automobiles, the intersection throughput could simply shut down to practically nothing.



These analyses demonstrate that the people-moving capacity of one automobile lane reaches its maximum limit at approximately 1,200 vehicles per lane per hour (which translated to a range of ~1,350 to ~1,450 people per lane per hour), presuming maximum optimal directional flow (as might be experienced late nights and weekend in highly off-peak times). But the people-moving capacity of automobile lanes in non-optimal conditions diminishes the greater the over-capacity experience becomes.

Conversely, the people-moving capacity of one dedicated RTV lane escalates the more the demand justifies higher occupancy of each RTV and justifies shorter headways.

Furthermore, these numeric comparisons of auto lane people-moving capacity versus the potential people-moving capacity of an RTV lane fail to account for yet another, potentially even more significant transformation that the proposed RTV system would offer. With smart land use planning of high density transit-oriented developments ("TOD's"), TODs create additional forms of non-SOV commuters beyond just RTV or other transit riders. TODs also change people's commuting behavior, because people in TODs can take advantage of the new land use patters arising from the more vibrant activity centers surrounding the availability of transit. This new commuting behavior can be in at least two different forms, either (1) in an entirely different mode of travel from either the automobile or an RTV, such as by walking, biking, or using a local circulator, car sharing program, or other form of non-SOV travel (all of which reduce people-moving demand on roadways and all of which thrive from a TOD community development); or (2) actual destinations are arranged more proximate to one another in TODs, and thus fewer and shorter trips are needed to serve people's objectives (e.g., the distance walked to pick up a gallon of milk or eggs by a resident in a TOD may be a tiny fraction of the distance traveled by automobile for the resident in a remote exurban/rural area). Collectively, these two forms of changed commuting behavior on account of smart

TOD planning substantially reduce the SOV transportation demands on our roadways and increases our people-moving capacity within available rights-of-way, even beyond the people-moving capacity of RTV lanes.

This was precisely the experience --- and the extraordinary benefits realized --- in Arlington, Virginia and in the Ballston Corridor in Northern Virginia. There, significant density increases were designed and constructed in "smart growth" transit oriented developments centered around transit stations. The result was to create vibrant, liveable, walkable, bikeable neighborhoods with a great sense of place and with densities that could absorb the growth of residents and workers (and their corresponding tax base increases). The tax base grew, an exciting and attractive destination with its own sense of place was formed, and the transportation congestion did not materialize in any way approaching the congestion now facing the more suburban and exurban corridors of Northern Virginia.

The bottom line conclusion: The people-moving **capacity of one auto lane DIMINISHES** as demand exceeds ~1,450 people per lane per hour; whereas, the people-moving **capacity of a dedicated RTV lane INCREASES** as demand exceeds ~1,450 people per lane per hour. And coupling this extraordinary people-moving capacity of RTV lanes with the additional benefits of changes in commuting behavior associated with TODs (as more fully described above), the combination of RTV lanes and smart TOD planning create a powerful force for significantly reducing SOV travel, and thereby significantly increase our people-moving capacity to meet the future demands.